REPORT
SOIL INVESTIGATION
PROPOSED SALT LAKE BOULEVARD WIDENING

OAHU STADIUM, HALAWA,
OAHU,
STATE OF HAWAII

582

TMK: 9-9-3: 48 & 62

for

THE STATE OF HAWAII
Department of Accounting and General Services

WILSON, OKAMOTO & ASSOCIATES
Architects

September 5, 1973
Project No. 117-026-01

MAURSETH HOWE ASSOCIATES
Consulting Foundation Engineers & Geologists

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MAURSETH HOWE ASSOCIATES
A CORPORATION
Consulting Foundation Engineers and Geologists

Honolulu, Hawaii
September 5, 1973

Job No. 117-026-01

State of Hawaii
Department of Accounting And
General Services
P. O. Box 119
Honolulu, Hawaii 96810

Attention: Mr. Rikio Nishioka,
State Public Works Engineer

Gentlemen:

The attached report represents the data, conclusions and recommendations of an investigation of the subsurface conditions at the site of the proposed Salt Lake Boulevard Widening, Oahu Stadium, Halawa, Oahu, State of Hawaii.

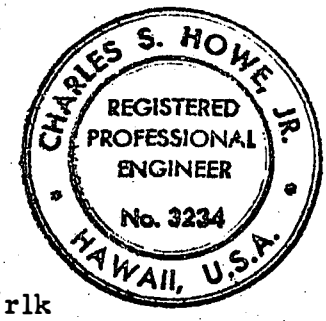
The details and scope of this investigation were discussed with Mr. Ken Nagai of Wilson, Okamoto & Associates, on April 25, 1973.

Based on the findings of this investigation, the proposed widening of Salt Lake Boulevard is feasible as planned. The investigation included three phases; (1) consideration of settlement resulting from placing up to seven feet of fill along the makai side of the existing road and a means of reducing settlements to tolerable limits, (2) recommendations pertinent to the additional piles required to widen the bridge from 60 feet to 100 feet, (3) recommendations for pavement design criteria based on the subgrade soil conditions along the existing roadway.

This investigation was made in accordance with generally accepted engineering procedures and included such field and laboratory tests considered necessary in the circumstances. In the opinion of the undersigned,

the accompanying report has been substantiated by mathematical data in conformity with generally accepted principles and presents fairly the design information requested by the State of Hawaii.

This investigation was performed under the supervision of the undersigned. Should you have any questions or require any further information, please do not hesitate to contact us.



Very truly yours,

MAURSETH, HOWE, ASSOCIATES

CSH/rlk

Charles S. Howe, Jr.

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INTRODUCTION

This investigation was made for the purpose of obtaining information on the subsurface soils on which to base recommendations for the proposed widening of Salt Lake Boulevard to a 100 foot wide right of way in the vicinity of Halawa Stream. The specific limits of the project are shown on the Plot Plan, Plates 2 and 3, which extends from Station 16 + 49.27 (north of the stream) to Station 31 + 00 (south of the stream).

SCOPE OF WORK

The investigation was discussed with Mr. Ken Nagai of Wilson, Okamoto & Associates, outlined in a Proposal dated May 15, 1973, and accepted by Consultant Contract Number 3656. The items included in the investigation are as follows:

1. Estimated settlements in areas where fill is to be placed, together with possible methods of accelerating the settlements, such as overloading the area aided by the use of vertical sand drains.

2. Recommendations regarding the type, lengths and vertical and horizontal capacities of piles to support the addition to the bridge. Estimated settlements of the piles.

3. Consideration of problems regarding the settlement of utility lines, particularly in the area of the bridge abutments.

4. Recommendations for pavement sections along the proposed road alignment.

PROPOSED DEVELOPMENT

It is presently proposed to widen the Salt Lake Boulevard right of way to 100 feet, which will provide 35 foot wide in-bound and out-bound lanes with a center divider strip. The future grade of the roadway will be approximately the same as the existing paved roadway, except for the northerly 200 feet which will be raised a maximum of two feet.

The existing 60 foot wide bridge crossing Halawa Stream will be widened 20 feet on each side, the additional width to be supported by a pile foundation similar to present bridge construction.

The west side of Salt Lake Boulevard, south of the bridge will require up to seven feet of fill to bring this portion of the right of way to grade. The width of this area varies from 30 to 40 feet in addition to the necessary area for sloping the fill to the existing surface.

SITE CONDITIONS

Surface,

The site is generally at or near the proposed grades except for the west side of the existing Salt Lake Boulevard, south of the bridge where the edge of the roadway slopes down approximately 7 feet to a relatively flat, open area. A dense growth of keawe trees covers this slope and the flat area below. Along the east side of Salt Lake Boulevard from Station 29 + 80 to the end of the project and beyond, there is an open, 8 foot wide, ten foot deep trench, supported by sheeting and wood shoring. An overload

fill extends south from the subject project on the west side of Salt Lake Boulevard and has been in place since September, 1972.

Subsurface

Subsurface soil conditions near the southern end of the project as disclosed by Borings No. 2 and 5, consist of approximately ten feet of firm clay underlain by soft to very soft, silty clays to depths ranging from 41 to 65 feet. This soft strata is underlain by moderately firm clays to the depths penetrated.

Between this area and the bridge, represented by Borings No. 3 and 4, the subsurface soils consist of firm to very firm, silty clays with varying sand content and isolated strata of dense sands to the final depths penetrated, except in Boring No. 6, where a sandy, silty gravel layer with clay seams was encountered from the ground surface to a depth of 23 feet, underlain by firm, silty clay.

Boring No. 1, at the bridge location, disclosed soft clays with scattered organic material to a depth of 46 feet, underlain by firm to very firm, silty, sandy clays. Boring No. 3 revealed firm to very firm, silty clay. A dense sand stratum was encountered at approximate elevation of -65 to -75 feet in Borings No. 1 and 3. Fill was encountered in Boring No. 3 to a depth of 10.5 feet.

A generalized soil profile inferred from the soils encountered along the line of borings, is presented on Plate 4. The ground water surface was encountered at elevations of +3 and +4.

CALCULATIONS AND DISCUSSIONS

I - Roadway Construction and Fill Placement

a. Settlements

1. Northern Section

The proposed seven feet of fill required to raise the west side widening to the required grade is expected to cause subsidence of the filled area and those immediately adjacent. The amount of subsidence will depend upon the types and thicknesses of the various underlying soil strata. Generally, from approximately Station 28 + 50 to the bridge, the settlement due to this fill imposition has been estimated at 1-1/2 to 3 inches, one third of which will occur rapidly with application of load, one third within the next year and the remainder over a much longer period.

Consideration was given to the effect of overloading this area to accelerate the settlement. At best, overloading might result in shortening the time for the first 1 to 2 inches to 3 to 6 months.

2. Southern Section

The soils beneath the proposed fill from approximately 28 + 50 to the south end of the project are softer and more compressible. It is estimated that the proposed seven feet of fill in this area will cause a subsidence of approximately 10 inches and because of the nature of the softer strata, this subsidence is expected to occur at a constantly diminishing rate over a period of some 150 years.

b. Settlement Acceleration

Two methods of accelerating this settlement were considered; (1) overloading by placing additional temporary fill, and (2) installing vertical sand drains to increase the rate of moisture flow from the consolidating clays. These two methods may also be combined to further accelerate this action.

Plate A presents estimated settlements plotted against time for various loading conditions, i.e., under the seven feet of fill, and with 5, 10, and 15 feet of surcharge.

The effect of overloading or surcharging the permanent fill, is to "force" the soil to consolidate at a faster rate and to allow such surcharge to remain in place for as long as possible so as to reduce the amount of residual settlement which will occur after its removal.

Vertical sand drains act to accelerate drainage of consolidating strata, thus reducing the time to reach a certain degree of consolidation under any imposed load. Sand drains are only effective in accelerating settlement due to "primary consolidation". The effectiveness of sand drains where horizontal free draining strata are not intersperced within the consolidation stratum is a function of the spacing of the drains since the flow toward each drain is radial. Studies were made to estimate the effectiveness of such spacing in terms of time reduction and the results are presented as follows:

$$\text{Time Reduction Factor} = \frac{\text{Consolidation time without sand drains}}{\text{Consolidation time with sand drains}}$$

Sand Drain Spacing (in feet) (18" diameter)	Time Reduction Factor
14.0	13.2
16.0	10.2
18.0	8.0
20.0	6.4

II - Bridge

It is proposed to widen the existing sixty (60) foot wide bridge an additional 20 feet on each side. The existing structure is supported on piles driven to elevations of - 72 to - 85 feet. It is anticipated that support of the addition will be the same as for the existing bridge, that is, extending the present pile caps, supported on 16-1/2 inch octagonal precast, pre-stressed concrete piles. Lateral support for the present structure is by means of battered piles.

III - Roadway Pavement Design

Investigation of existing subgrade soils beneath the present roadway was undertaken by means of a series of seven test pits, the locations of which are shown on Plates 2 and 3, in the Appendix.

Samples of the subgrade soils were subjected to laboratory tests to establish atterberg limits, grain size distribution and California Bearing

Ratios with associated data. The results of the tests are shown on Plate No. 22, in the Appendix.

CONCLUSIONS AND RECOMMENDATIONS

I. Proposed Fill Placement

The depth of surcharge over the proposed permanent fill and the use and spacing of sand drains should be selected to reduce residual settlements to a tolerable amount. The curves presented on Plate A, and the Time Reduction Factors may be used to estimate the residual settlement for any set of conditions. This office will be available to interpret these data should such assistance be desired.

Permanent fills should be placed and compacted to such a height as to provide for the expected subsidence. It is recommended that at least one foot of excess permanent fill be placed. It is essential that all permanent fill be constructed and compacted in accordance with regulations of the City and County of Honolulu.

Surcharge fill need not be compacted, except for the last foot to provide a working surface for access to the area and to minimize water infiltration.

It is recommended that the level surcharged area extend at least ten feet beyond the edge of the permanent fill.

Settlement markers should be placed prior to placement of fill in order to monitor the time rate of settlement.

Lateral Stability

The gross stability of the proposed fills including any surcharge fills has been investigated with respect to a possible lateral movement of the fills in a westerly direction. The analysis is based on shear parameters of subsurface soils beneath the proposed fills. Calculations show that fills up to twenty-two (22) feet in height, that is, seven (7) feet of permanent fill and fifteen (15) feet of surcharge, will have a calculated factor of safety of 1.9, against a shear failure which is considered adequate.

Vertical Sand Drains

It is recommended that vertical sand drains be eighteen (18) inches in diameter and in all cases extend to the bottom of the soft clay which was encountered to depths of 66 to 41 feet in Borings No. 2 and 5 respectively.

Drained backfill material for the sand drains and blanket shall have sufficient permeability to discharge the pore water flow anticipated. Clean sands with no more than three (3) percent, by weight, passing the No. 200 sieve is usually suitable.

II - Bridge

It is understood that a design pile capacity for vertical loads up to 32 tons will be required, using 16-1/2 inch octagonal prestressed, precast concrete piles. To achieve this capacity it is recommended that the tips of all piles penetrate to an elevation of at least - 70 feet.

A test driving program is recommeded in order to evaluate driving conditions and to establish probable lengths of piles to be orderd. It is recommended that for each twenty (20) foot wide section, three test piles be driven; one at each end and one in the central area. Final driving resistances and penetration criteria should be determined by or in corroboration with the Foundation Engineer.

Tentatively the following specifications are recommended:

Using a hammer with a rated energy of 26,000 foot pounds per blow, it is recommended that a penetration resistance of at least three (3) blows per inch for the last three inches and at least 30 blows for the last foot be achieved. It is expected that piles will have to be driven to elevations of - 70 to - 85 feet.

The lateral resistance of piles to horizontal forces are limited by strength of the relative soft near surface soils. It is recommended that the resistance of such piles be limited to 4,000 pounds per pile. The point of fixity (point of maximum moment), should be assumed to be ten feet below the lowest adjacent ground surface.

Since the present bridge structure appears to be designed so as to carry horizontal forces by means of batter piles, it is strongly recommended that this method be used for the addition.

Load Test

A pile load test is recommended and is required by local building laws for all piles with a design capacity over forty (40) tons.

The test should be performed in accordance with applicable ASTM procedures and requirements of agencies having jurisdiction, and shall be so confirmed by the Foundation Engineer.

After the test is completed, the Foundation Engineer will review the results and recommend acceptance or modification of the assumed bearing.

III - Pavement Design

The recommended pavement design for the proposed subgrade is based on the Asphalt Institute Thickness Design Manual, Series No. 1 (MS - 1), dated August, 1970. The Initial Daily Traffic (IDT) of 11,000 vehicles, taken by the City and County of Honolulu on April 4, 1973, and the following assumed values, were used in the pavement design:

a. Ten percent of IDT are 30,000 pounds average, gross weight trucks.

b. Forty percent of the trucks will use the Design Lane (heaviest travel lane).

c. The legal single-axle load limit is 24,000 pounds.

d. The traffic growth rate is four percent annually.

e. The design period is twenty years.

f. Traffic designation : heavy (DTN = 900).

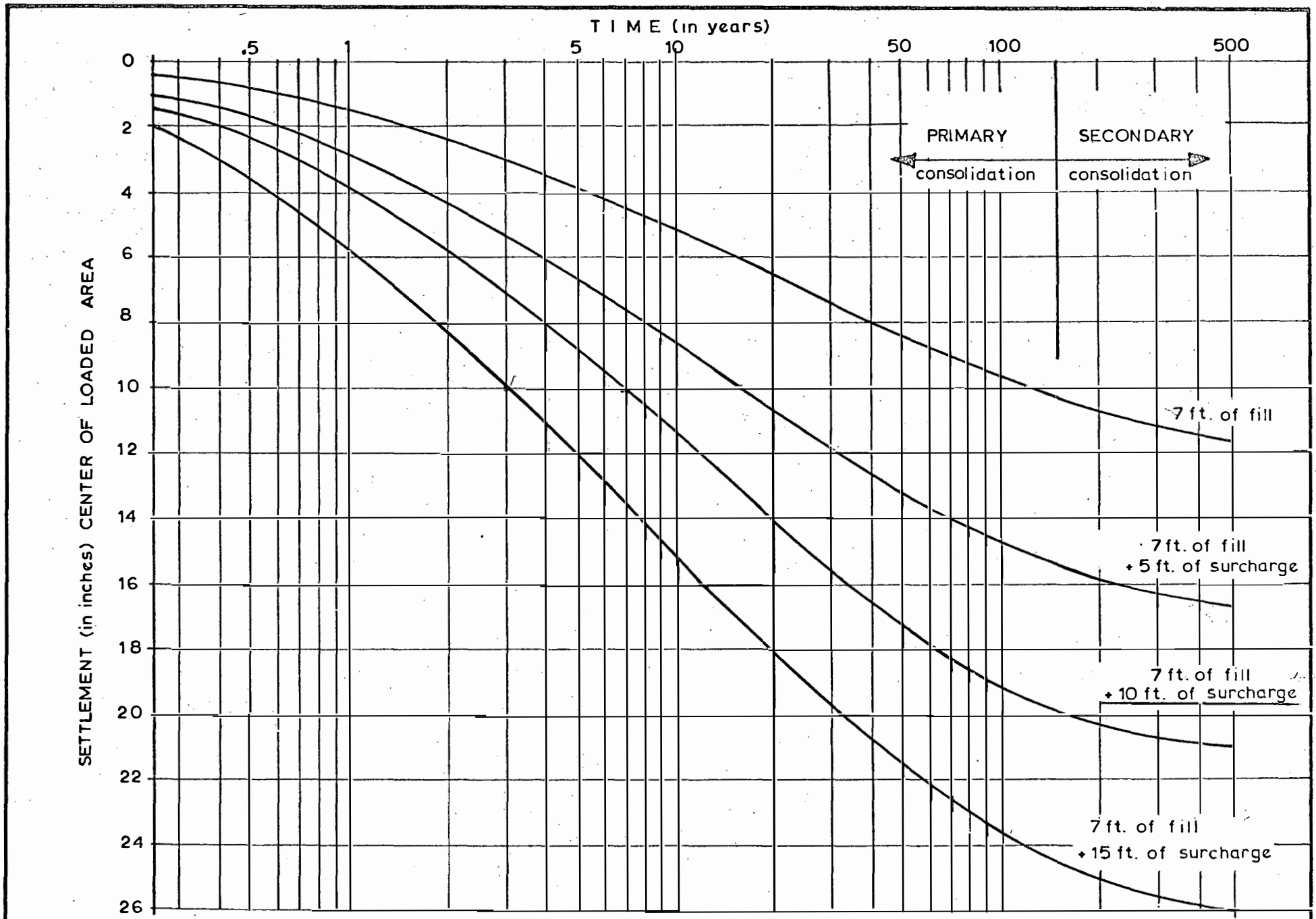
The following is a summary of test results and recommended pavement sections at the various test locations:

Test Pit No.	1	2	3	4
Soil Description	GRAVEL (GM) brown	SAND (SC) dark brown	CLAY (CH/MH) grey brown	CLAY (CH/MH) dark brown
CBR @ 0.1" penetration	69.7	53.0	4.8	4.9
Recommendations:				
A. C.	3"	3"	3"	3"
Base	6"	6"	8"	8"
Select Borrow	0	0	12"	12"

Test Pit No.	5	6	7
Soil Description	SILT (ML) brown	CLAY (CL) brown	CLAY (CH) dark brown
CBR @0.1" penetration	11.0	11.3	8.2
Recommendations:			
A. C.	3"	3"	3"
Base	6"	6"	6"
Select Borrow	6"	6"	10"

Should soils other than those indicated be found during grading, the above pavement thicknesses will be subject to modifications. All materials used and work done shall conform to the City and County of Honolulu "Standard Specifications For Public Works", dated November, 1968.

Tabulation of the test results and recommendations are presented on Plate No. 22, in the Appendix to this report.



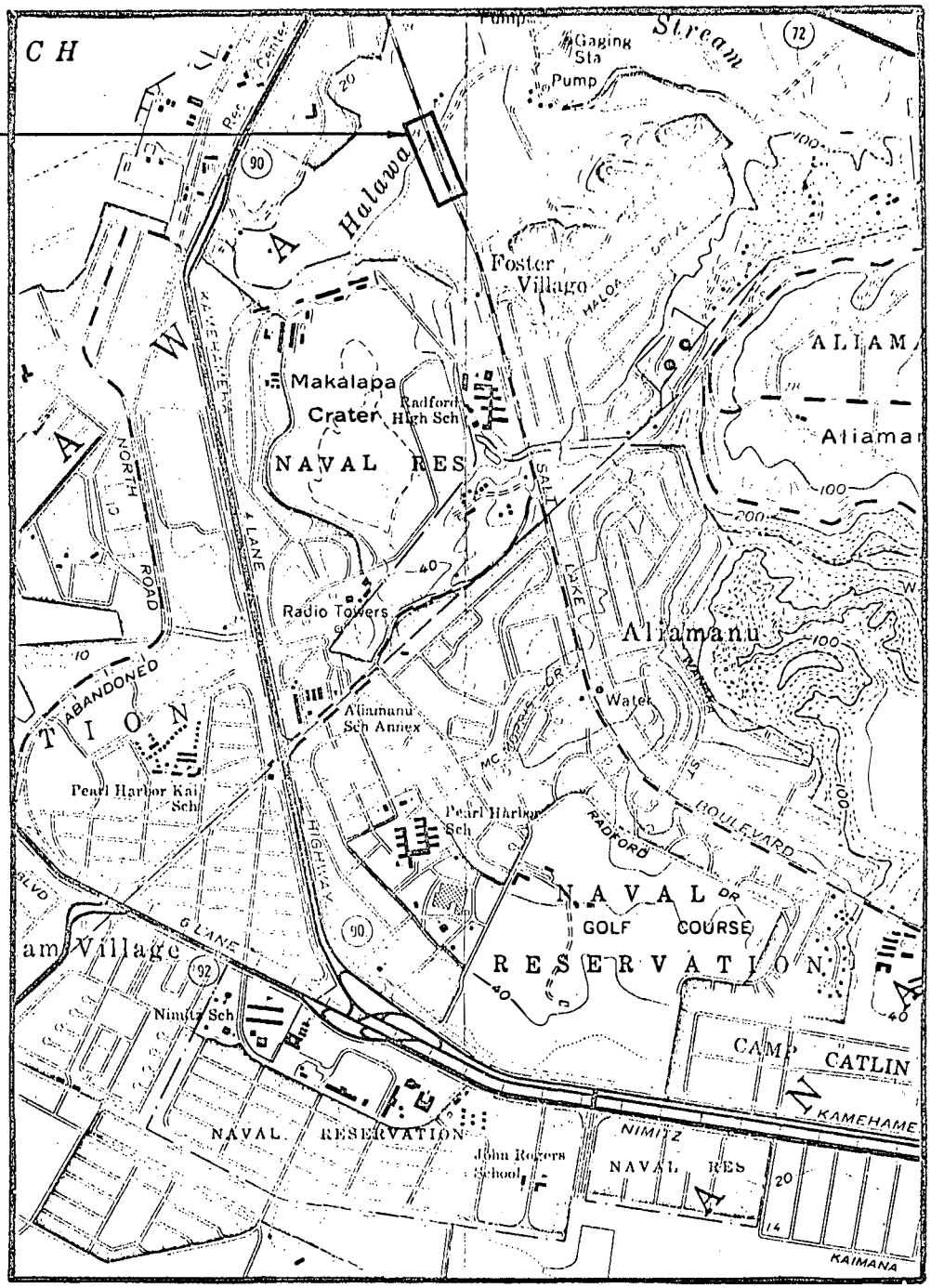
SALT LAKE BOULEVARD WIDENING

PLATE NO. A

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO. 117-026-01

VICINITY MAP



REFERENCE

USGS Topographic Survey
Puuloa Quadrangle, Oahu
Dated 1959

SALT LAKE BOULDEVARD WIDENING	PLATE NO 1
MAURSETH HOWE LOCKWOOD & ASSOC.	FILE NO 117-026-01

APPENDIX

FIELD INVESTIGATION AND LABORATORY TESTING

Field Investigation

A. Bridge and Roadway Fill Areas

Seven (7) borings were drilled to depths ranging from 25 to 110 feet. The borings were drilled with truck-mounted, helical auger drilling equipment, using a four (4) inch diameter bit. The locations of these borings are shown on the Plot Plan, Plates 2 and 3. Detailed logs of the soils and rock encountered are presented on Plates 4 through 10, Log of Borings.

Undisturbed samples were obtained by driving a sampling tube into the underlying soils and rock at various intervals below the surface by means of a heavy driving weight dropping on sampler rods. The sampling tube consists of a steel barrel, 2.50 inches inside diameter, with an interior lining of one (1) inch long, thin brass rings. The sampling tube is driven approximately eighteen (18) inches into the soil and a section of the central portion of the sample is taken to the laboratory in a closely fitted, water-proof container in order to retain the field moisture until completion of the tests. The driving energy required to drive the sampler one (1) foot into the undisturbed soil, as noted on the Log of Borings in Blows per Foot, is approximately equivalent to the Standard Penetration Test.

B. Pavement Subgrade

Seven (7) shallow test pits were excavated with a backhoe. Bulk samples of the soil encountered were taken from each test pit for laboratory testing. The locations of these test pits are shown on the Plot Plan,

Plates 2 and 3. Detailed logs of the soils encountered are presented on Plates 11 through 17, Log of Test Pits.

Laboratory Testing

A. Bridge and Roadway Fill Areas

Samples were selected for laboratory testing following a review of the field investigation. Tests performed included determination of unit weight and moisture content, shearing resistance and load consolidation characteristics.

The in-place moisture content and density tests of samples obtained were made to correlate between similar samples. One or more one (1) inch long sections of the sample are cut, trimmed, weighed, oven dried, and reweighed. From these measurements, the unit weight of the solids in pounds per cubic foot and the percent of moisture are calculated. The test results are presented on the Log of Borings, Plates 4 through 10.

Direct shear tests were performed to determine the strength characteristics of the soils encountered. Each sample is sheared under a normal load approximately equivalent to the expected overburden. By varying the normal load on a particular sample, the angle of internal friction and cohesion may be determined. The test results are presented on the Log of Borings, Plates 4 through 10.

Representative samples of the subsurface soils were tested to determine the settlement characteristics. The test is performed by placing

a one (1) inch thick specimen of soil in the consolidation apparatus. Loads are applied in increments to the face of the specimen. Deformation or changes in thickness of the specimen are recorded at select time intervals. Water is introduced to, or allowed to drain from the sample through porous disks placed against the top and bottom faces of the specimen. From this data, settlements and time rate of consolidation are determined. Results of these tests are presented on Plates 18 through 21.

B. Pavement Subgrade

Samples of the subgrade soils were tested to determine grain size distribution by means of sieves, atterberg limit tests to determine liquid and plastic limits, and the California Bearing Ratios. The results are presented on Plate No. 22.

LIST OF PLATES

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MAIN OFFICE
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MAURSETH • HOWE • ASSOCIATES

A CORPORATION
Consulting Foundation Engineers and Geologists

Honolulu, Hawaii
February 1, 1974

Project No. 117-026-01

State of Hawaii
Department of Accounting And
General Services
P. O. Box 119
Honolulu, Hawaii 96801

Attention: Mr. Roy Kimura

PROJECT REFERENCE: Salt Lake Boulevard Widening
Halawa Stream, Oahu, Hawaii

Gentlemen:

We have reviewed the C-6 Sheets prepared by Wilson, Okamoto Associates, Arhcitects and Engineers for the above referenced project and we herewith submit our recommendations:

Item I

It is recommended that the sand drain layout be as shown on the attached drawing.

Item II

Extend the level portion or top of the surcharge fill to the right-of-way, then slope downward to the existing ground surface.

Item III

Rearrange the locations of the settlement platforms such that three settlement platforms would be along the same line as that shown on the C-2 drawing, except place them at approximately Stations 28+30, 29+40 and 30+40. In addition, place two platforms within the surcharge fill but near the

toe of the 1 horizontal to 1 vertical fill slope. These platforms should be set at approximately Stations 28+80 and 29+90.

Item IV

The surcharge fill zone where the 1 horizontal to 1 vertical slope is to be constructed should be compacted to at least 90 percent of the maximum dry density as determined by ASTM D - 1557.

Item V

In order to resist erosion caused by water infiltration, the surface (uppermost 12 inches) of the surcharge including the flat top area and the 2 horizontal to 1 vertical slope should be compacted.

Should you have any questions, please call on us.

Very truly yours

MAURSETH HOWE ASSOCIATES

Charles S. Howe, Jr.

CSH/rlk

cc: Wilson, Okamoto & Associates

LOG OF BORING NO 1

DATE DRILLED July 25, 1973

EQUIPMENT USED Truck Mounted Auger, 4" Ø

ELEV OF SURFACE 2.9'*

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
							CONCRETE			
0.60	0.72	62	62.0	4		5	CLAY, silty, sandy (CL)	light brown	sat.	mod. firm
		57	85.0	3		10	some organic material (OL)	dark grey		soft
1.60	0.45	52	85.2	3		15				
		63	54.2	2		20	some gravels			
2.55	0.85	52	81.2	3		25				
		70	38.4	5		30	scattered gravel to 3"			
		62	65.4	4		35				
		52	70.0	4		40	some shells			
4.60	0.70	62	61.9	4		45				firm
3.50	1.62	87	47.6	26		50	(Continued)			

Ref. Elev. from Worksheet by DAGS Survey Division, Dated May 10, 1973

SALT LAKE BOULEVARD WIDENING | PLATE NO 4

MAURSETH HOWE LOCKWOOD & ASSOC. | FILE NO 117-026-01

LOG OF BORING NO 1 (Con't)

DATE DRILLED

EQUIPMENT USED

ELEV OF SURFACE

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
				102	X	55	CLAY, silty, sandy, organic (OL) basalt boulder	dark grey	sat.	firm
4.06	1.69	87	45.5	56		60	silty (CL)	med. brown		
4.30	2.24	81	52.3	18		65				
						70	SAND, silty, cinders. (SM)	brown		dense
4.96	3.45	64	62.4	30		75				
						80	CLAY, silty (CL)	light grey & brown		very firm
5.56	3.45	59	67.9	26		85				
						90				
6.16	3.50	69	56.8	18		95		brown		
						100	(Continued)			

PLATE NO 4 (con't)

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO 117-026-01

LOG OF BORING NO 1 (Con't)

DATE DRILLED

EQUIPMENT USED

ELEV OF SURFACE

DESCRIPTION OF SOILS

CONFINING PRESSURE kips / sq ft	SHEAR STRENGTH kips / sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
							CLAY, silty (CL)	brown	sat.	very firm
6.76	3.90	69	55.6	29		105				
7.00	3.70	74	50.3	25		110	End of Boring @ 110.0' Ground water surface was not measured since boring location was in channel with running water.			

PLATE NO 4(con't)

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO 117-026-01

LOG OF BORING NO 2

DATE DRILLED July 27, 1973

EQUIPMENT USED Truck Mounted Auger, 4" Ø ELEV OF SURFACE 13.0'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
							CLAY, silty (CL)	brown	very moist	mod. firm
0.58	1.50	78	38.3	7		5				
							organic material (OL)	brown	▽	soft
1.09	0.63	67	62.3	3		10				
						15				
		69	55.7	4						
						20				
		76	50.2	4			sandy, gravelly (CH)			
						25	organic material CLAY, SILTY, OR GAVIC (OL)			very soft
		46	109.7	2		30				
						35				
		57	73.3	2		40				
						45				
3.45	0.37	66	57.4	3		50	(Continued)			

SALT LAKE BOULEVARD WIDENING | PLATE NO 5

MAURSETH HOWE LOCKWOOD & ASSOC. | FILE NO 117-026-01

LOG OF BORING NO 2 (Con't)

DATE DRILLED

EQUIPMENT USED

ELEV OF SURFACE

DESCRIPTION OF SOILS

CONFINING PRESSURE kips / sq ft	SHEAR STRENGTH kips / sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
							CLAY, silty, organic (OL)	brown	sat.	very soft
3.76	0.76	67	57.9	5		55				
						60				
		71	55.2	11		65	very silty, no organic material (CL)	dark brown		mod. firm
4.66	2.22	71	55.5	15		70				firm
4.96	2.80	60	70.3	28		75				very firm
						80	sandy, silty	orange brown		firm
5.56	2.87	73	53.5	22		85				
						90				
6.16	3.55	66	60.2	12		95				mod. firm
						100	silty, no sand (CL)	brown		firm

(Continued)

PLATE NO 5(con't)

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO

LOG OF BORING NO 2 (Con't)

DATE DRILLED

EQUIPMENT USED

ELEV OF SURFACE

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						105	CLAY, silty no sand (CL)	brown	sat.	firm
				11						
7.00	2.85	54	78.6	18		110				
							End of Boring @ 110.0' Water Encountered @ 10.5'			

PLATE NO 5(con't)

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO

LOG OF BORING NO 3

DATE DRILLED July 31 to August 3, 1973

EQUIPMENT USED Truck Mounted Auger, 4" Ø ELEV OF SURFACE 14.0'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						0	FILL: CLAY, silty, sandy with gravels, some roots (CL)	brown	moist	firm
0.60	4.00	96	23.4	16		5				
1.10	1.32	66	56.7	4		10	CLAY, silty, sandy, some organic material (CL)	grey brown		mod. firm
						15	no organic material	brown		firm
1.66	1.71	79	45.9	19		20				
						25	less sand			
2.26	1.75	64	63.0	15		30				
						35				
2.86	1.51	63	63.6	18		40		orange brown		
						45				
						50				

(Continued)

SALT LAKE BOULEVARD WIDENING | PLATE NO 6

MAURSETH HOWE LOCKWOOD & ASSOC. | FILE NO 117-026-01

LOG OF BORING NO 3 (Con't)

DATE DRILLED

EQUIPMENT USED

ELEV OF SURFACE

DESCRIPTION OF SOILS

CONIFINING PRESSURE kips / sq ft	SHEAR STRENGTH kips / sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
3.50	2.50	65	60.9	12		55	CLAY, silty, some sand (CL)	orange brown	sat.	firm
							no sand (CH)			very firm
				45	X	60				
						65				
4.36	3.03	69	55.5	40						
						70				
4.96	3.42	61	67.6	28		75				
5.30	3.17	82	43.1	26		80	some sand (CL)			
5.60	2.88	72	52.7	19		85				
							SAND, medium to coarse, gravelly (SW)			dense
5.86	4.13	79	31.2	17		90				
							CLAY, silty, sandy (CL)			firm
6.18	3.40	68	56.6	16		95				
						100				
6.46	3.92	57	74.6	20			(Continued)	blue grey		

PLATE NO 6(con't)

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO

LOG OF BORING NO 3 (Con't)

DATE DRILLED

EQUIPMENT USED

ELEV OF SURFACE

DESCRIPTION OF SOILS

CONFINING PRESSURE kips / sq ft	SHEAR STRENGTH kips / sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						105	CLAY, silty, sandy (CL)	blue grey	sat.	firm
6.97	3.50	67	59.2	23		110		brown		
							End of Boring @ 110.0' Water Encountered @ 10.7'			

PLATE NO 6(con't)

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO

LOG OF BORING NO 4

DATE DRILLED August 6, 1973

EQUIPMENT USED Truck Mounted Auger, 4" Ø ELEV OF SURFACE 13.1'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						0	CLAY, silty (CL)	brown	moist	mod. firm
		69	36.8	6		5				
		78	40.2	4		10	SAND, clayey, numerous gravels and cobbles (SC)	orange brown		mod. dense
		91	42.8	11		15				
		62	65.6	18		20	CLAY, silty, sandy with gravels (CL)	dark brown		firm
		86	46.4	21		25				
		73	46.4	20		30	silty (CH)	brown		
		71	52.7	23		35	SAND, very silty, numerous cobbles (SM)	orange brown		dense
		64	64.0	12		40	CLAY, very silty, sandy (CL)			firm
		59	68.4	21		45	no sand (CH)	blue grey		
						50	some sand (Continued) (CL)			

SALT LAKE BOULEVARD WIDENING

MAURSETH HOWE LOCKWOOD & ASSOC.

PLATE NO 7

FILE NO 117-026-01

LOG OF BORING NO 4 (Con't)

DATE DRILLED

EQUIPMENT USED

ELEV OF SURFACE

DESCRIPTION OF SOILS

CONFINING PRESSURE kips / sq ft	SHEAR STRENGTH kips / sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
		67	59.2	12			CLAY, very silty, some sand (CL)	orange brown	sat.	firm
		66	59.3	11		55				
		79	43.8	18		60				
							End of Boring @ 60.0' Water Encountered @ 9.7'			

PLATE NO 7(con't)

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO

LOG OF BORING NO 5

DATE DRILLED August 7 & 8, 1973

EQUIPMENT USED Truck Mounted Auger, 4" Ø ELEV OF SURFACE 12.4'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
							CLAY, very silty, some sand (CL)	brown	moist	firm
		76	41.3	9		5				
		61	67.1	2		10				soft
		67	58.7	2		15	silty, numerous shells organic material, some cobbles (OL)	dark grey		
		55	105.9	3		20	no cobbles			
						25				
		64	60.5	2		30				
						35				
		71	52.3	10		40	silty, sandy (CL)			firm
				17		45				
						50				
							(Continued)			

SALT LAKE BOULEVARD WIDENING

MAURSETH HOWE LOCKWOOD & ASSOC.

PLATE NO 8

FILE NO 117-026-01

LOG OF BORING NO 5 (Con't)

DATE DRILLED

EQUIPMENT USED

ELEV OF SURFACE

DESCRIPTION OF SOILS

CONIFINING PRESSURE kips / sq ft	SHEAR STRENGTH kips / sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
				28			CLAY, silty, sandy (CL)	dark	sat.	firm
		61	64.9	11		55		orange brown		
		62	66.5	12						
						60	End of Boring @ 56.5' Water Encountered @ 9.9'			

PLATE NO 8(con't)

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO

LOG OF BORING NO 6

DATE DRILLED August 8, 1973

EQUIPMENT USED Truck Mounted Auger, 4" Ø

ELEV OF SURFACE 13.5'

DESCRIPTION OF SOILS

CONIFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						0	GRAVEL, very sandy, silty (GM)	orange brown	moist	dense
			21.9	20		5				
						10	clay seams			
			21.2	11			(GC)			
				11		15				
				43/6"		20	no clay seams	grey		
		83	40.6	13/6"		25	CLAY. silty (CH)	brown		firm
							End of Boring @ 25.5'			
							Water Encountered @ 10.1'			
						30				

SALT LAKE BOULEVARD WIDENING

PLATE NO 9

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO 117-026-01

LOG OF BORING NO 7

DATE DRILLED August 8, 1973

EQUIPMENT USED Truck Mounted Auger, 4" Ø ELEV OF SURFACE 13.5'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						0	CLAY, very silty (CL)	orange brown	moist	mod. firm
		70	54.6	7		5				
		74	44.2	7		10				
						15	SAND, silty (SM)	dark grey		dense
		68	55.9	6				orange brown		
						20	CLAY, silty, some sand (CL)			firm
		66	60.6	12						
						25		orange brown & grey		
		79	41.9	12						
		72	51.1	18		30				
						35	End of Boring @ 31.5' Water Encountered @ 11.0'			

SALT LAKE BOULEVARD WIDENING

PLATE NO 10

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO 117-026-01

LOG OF TEST PIT NO 1

DATE August 20, 1973
EQUIPMENT USED Backhoe

ELEV OF SURFACE 18.1'*

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						0	FILL: GRAVEL, silty, sandy, large boulders (GM)	brown	mod. moist	firm
						1				
						2				
						3	End of Test Pit @ 3.0' No Water Encountered			

Ref. Elev. from Worksheet by DAGS Survey Division, Dated May 10, 1973

SALT LAKE BOULEVARD WIDENING

PLATE NO 11

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO 117-026-01

LOG OF TEST PIT NO 2

DATE August 20, 1973
EQUIPMENT USED Backhoe

ELEV OF SURFACE 17.6'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						1	FILL: CORAL LIMESTONE	tan	mod. moist	firm
						2	SAND, clayey (SC)	red brown		
						3		dark brown		
							End of Test Pit @ 3.0' No Water Encountered			

SALT LAKE BOULEVARD WIDENING

PLATE NO 12

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO 117-026-01

LOG OF TEST PIT NO 3

DATE August 20, 1973

EQUIPMENT USED Backhoe

ELEV OF SURFACE 18.4'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						1	FILL: CLAY, silty, some sands and gravels (CH/MH)	grey brown	moist	firm
						2				
						3	End of Test Pit @ 3.0' No Water Encountered			

SALT LAKE BOULEVARD WIDENING

PLATE NO 13

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO 117-026-01

LOG OF TEST PIT NO 4

DATE August 20, 1973
EQUIPMENT USED Backhoe
ELEV OF SURFACE 17.9'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						1	FILL: CLAY, silty, gravelly (CH/MH)	brown	mod. moist	firm
						2				
						3	End of Test Pit @ 3.0' No Water Encountered			

SALT LAKE BOULEVARD WIDENING — PLATE NO 14

MAURSETH HOWE LOCKWOOD & ASSOC. — FILE NO 117-026-01

LOG OF TEST PIT NO 5

DATE August 20, 1973
EQUIPMENT USED Backhoe
ELEV OF SURFACE 16.8'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						1	SILT, clayey, some gravel (ML)	brown	mod. moist	firm
						2				
						3	End of Test Pit @ 3.0' No Water Encountered			

SALT LAKE BOULEVARD WIDENING — PLATE NO 15

MAURSETH HOWE LOCKWOOD & ASSOC. — FILE NO 117-026-01

LOG OF TEST PIT NO 6

DATE August 20, 1973
EQUIPMENT USED Backhoe
ELEV OF SURFACE 17.0'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						1	FILL: CLAY, silty with gravel, some boulders. (CL)	brown	mod. moist	firm
						2				
						3	End of Test Pit @ 3.0' No Water Encountered			

SALT LAKE BOULEVARD WIDENING

MAURSETH HOWE LOCKWOOD & ASSOC.

PLATE NO 16

FILE NO 117-026-01

LOG OF TEST PIT NO 7

DATE August 20, 1973
EQUIPMENT USED Backhoe

ELEV OF SURFACE 17.8'

DESCRIPTION OF SOILS

CONFINING PRESSURE kips/sq ft	SHEAR STRENGTH kips/sq ft	DRY DENSITY lbs per cu ft	PERCENT MOISTURE	BLOWS PER FOOT	SAMPLE	DEPTH IN FEET	CLASSIFICATION	COLOR	MOISTURE	CONSISTENCY
						1	CLAY, some organic material (CH)	dark brown	very moist	mod. firm
						2				
						3	End of Test Pit @ 3.0' No Water Encountered			

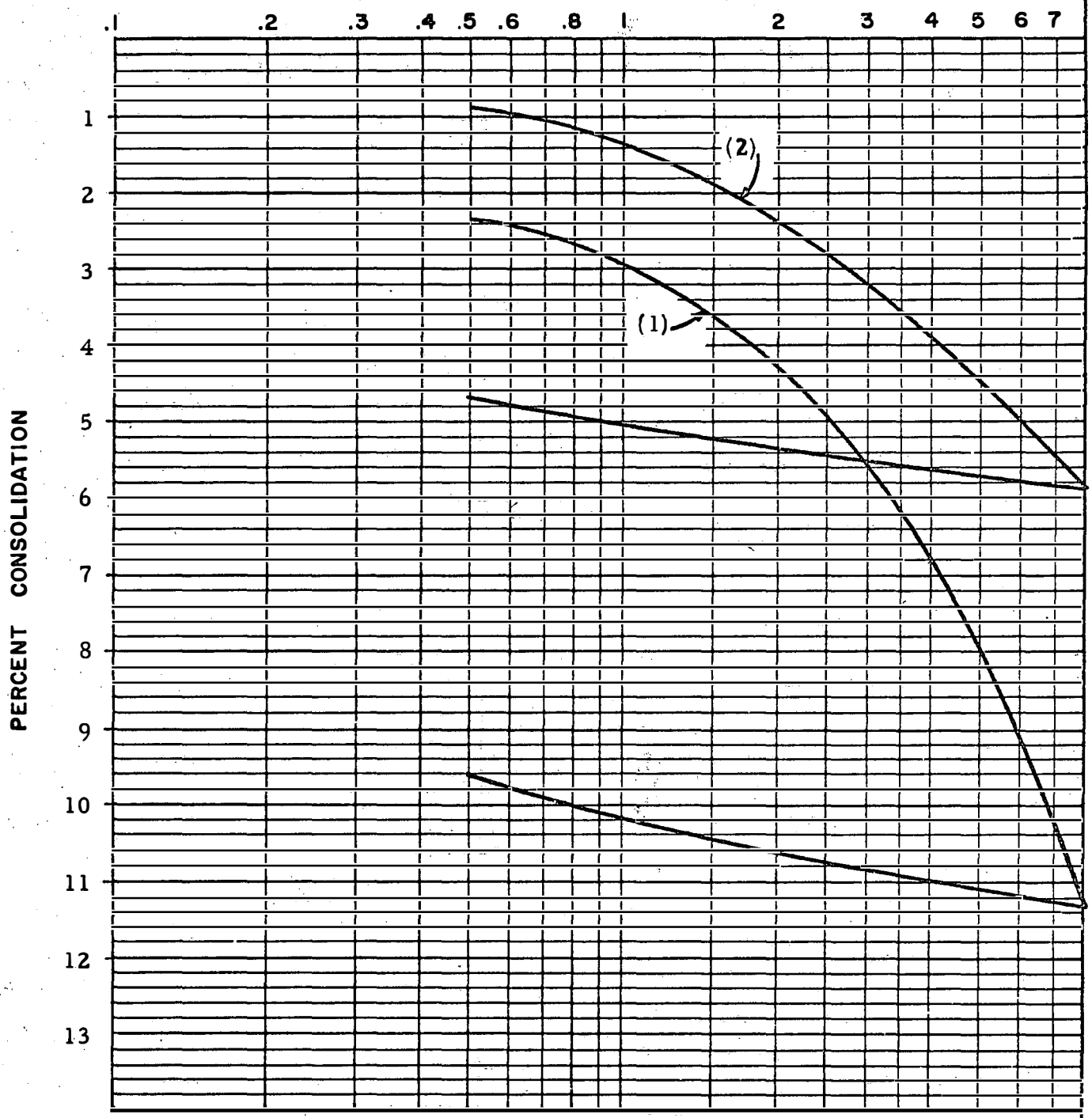
SALT LAKE BOULEVARD WIDENING

PLATE NO 17

MAURSETH HOWE LOCKWOOD & ASSOC.

FILE NO 117-026-01

CONSOLIDATION TEST DATA

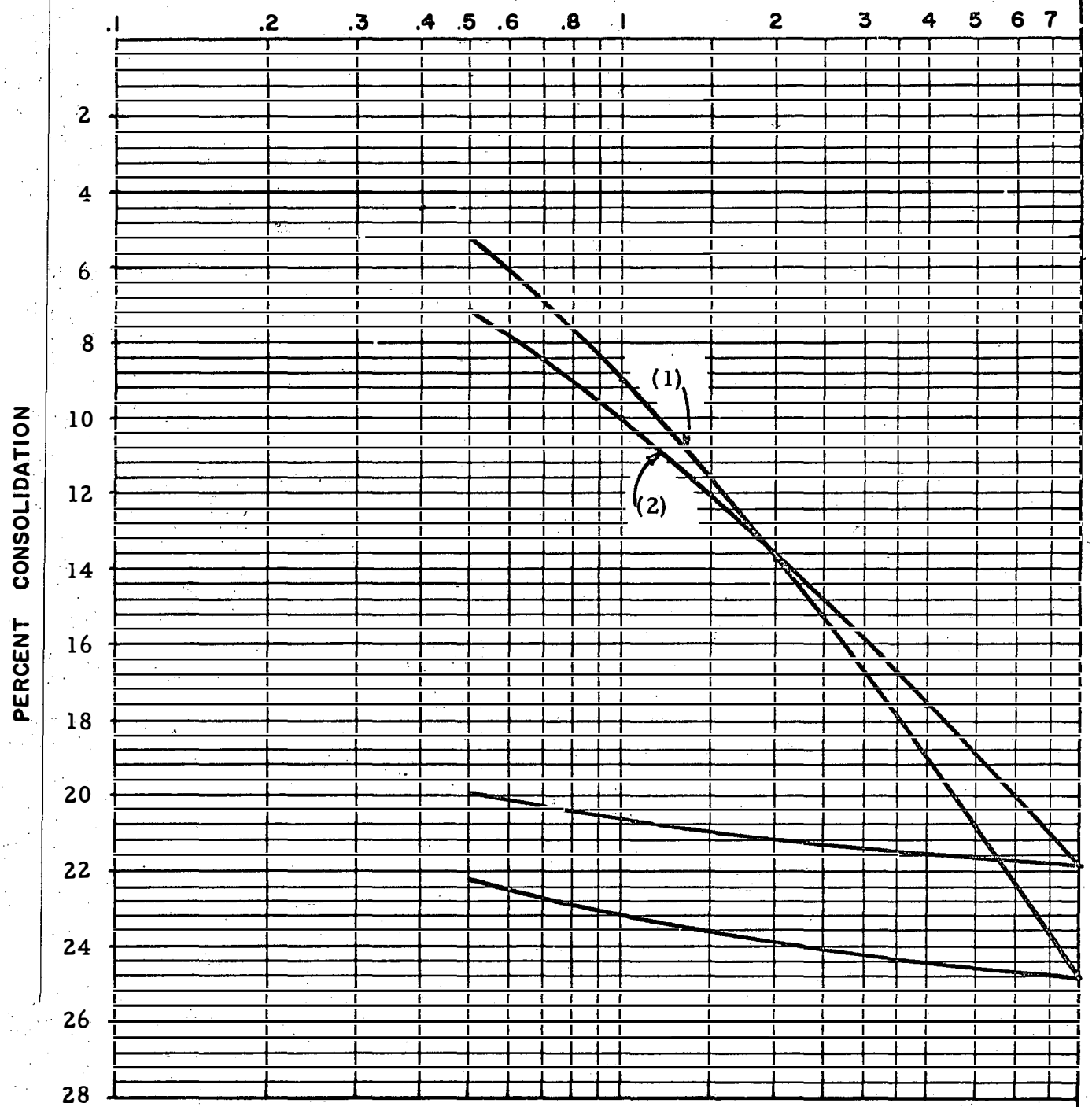


(1) Boring No. 2, Sample No. 2 @ 10.9',

(2) Boring No. 2, Sample No. 10 @ 71.0'

SALT LAKE BOULEVARD WIDENING	PLATE NO 18
MAURSETH HOWE LOCKWOOD & ASSOC.	FILE NO 117-026-01

CONSOLIDATION TEST DATA

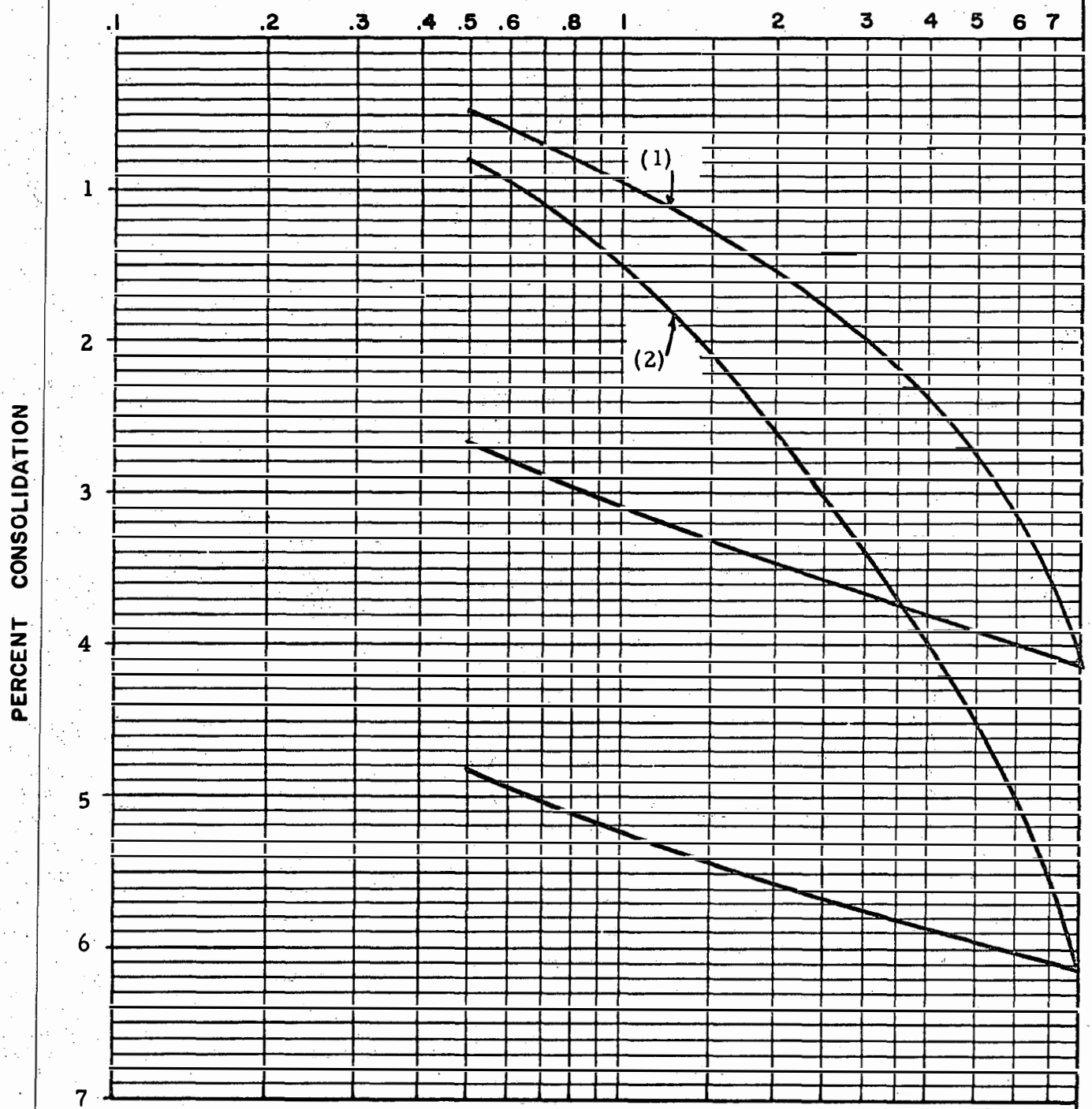


(1) Boring No. 2, Sample No. 5 @ 30.5'

(2) Boring No. 2, Sample No. 6 @ 41.0'

SALT LAKE BOULEVARD WIDENING	PLATE NO 19
MAURSETH HOWE LOCKWOOD & ASSOC.	FILE NO 117-026-01

CONSOLIDATION TEST DATA



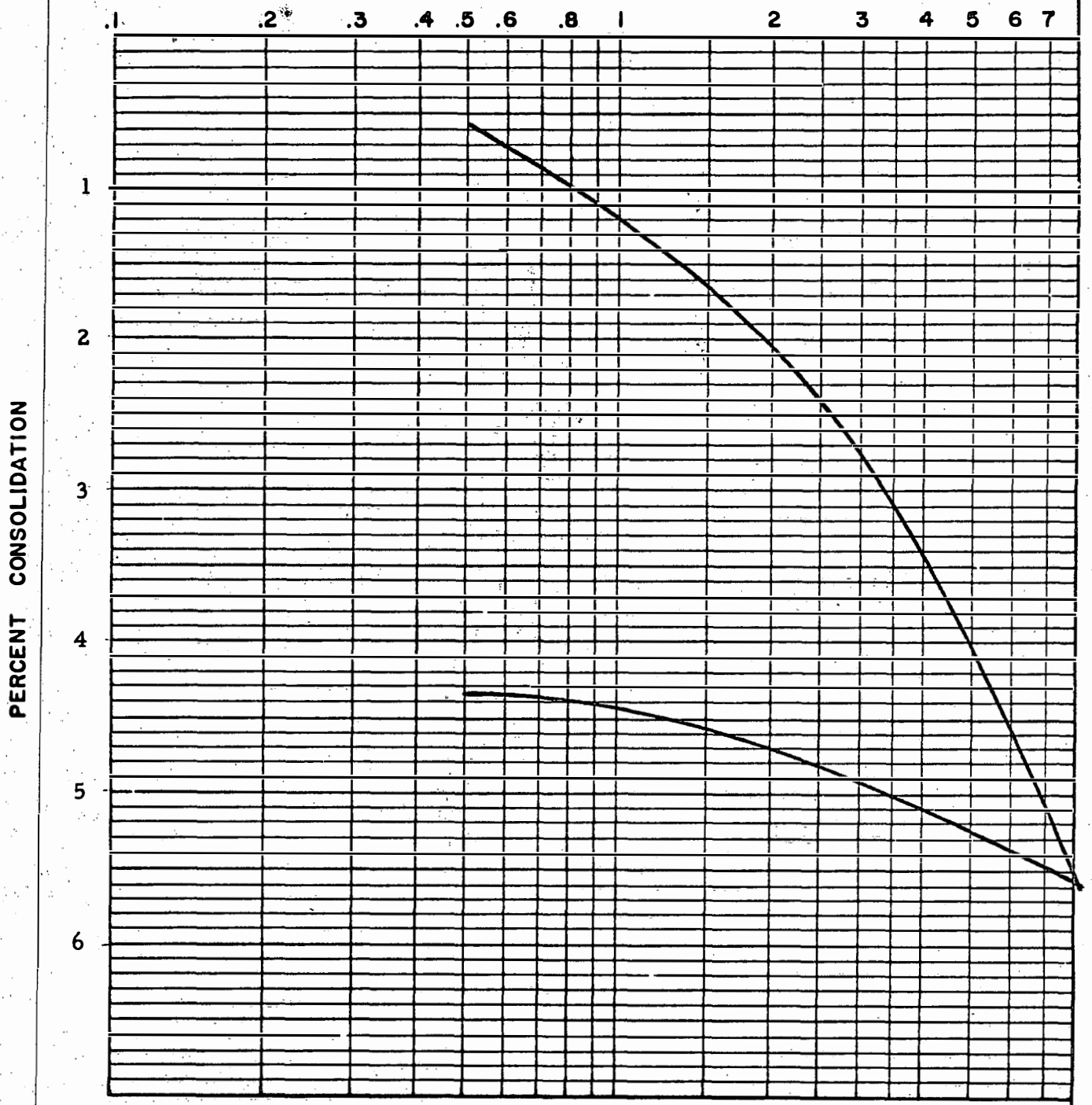
(1) Boring No. 3, Sample No. 2 @ 11.0'

(2) Boring No. 3, Sample No. 4 @ 31.0'

SALT LAKE BOULEVARD WIDENING	PLATE NO 20
MAURSETH HOWE LOCKWOOD & ASSOC.	FILE NO 117-026-01

CONSOLIDATION TEST DATA

PRESSURE IN KIPS PER SQUARE FOOT



Boring No. 4, Sample No. 6 @ 31.0'

SALT LAKE BOULEVARD WIDENING	PLATE NO 21
MAURSETH HOWE LOCKWOOD & ASSOC.	FILE NO 117-026-01

SUMMARY OF TEST RESULTS

Test Pit No.	1	2	3	4	5	6	7
Location (station)	29 + 70	27 + 15	28 + 50	25 + 55	21 + 80	19 + 00	16 + 50
Soil Description	GRAVEL (GM)	SAND (SC)	CLAY (CH/MH)	CLAY (CH/MH)	SILT (ML)	CLAY (CL)	CLAY (CH)
CBR @ 0.1" Penetration	69.7	53.0	4.8	4.9	11.0	11.3	8.2
Expansion, %	N/E	0.2	6.4	6.1	2.2	2.5	5.8
Moisture Content, %	16.0	20.5	30.0	27.0	29.0	27.0	26.0
Dry Density, lbs/c.f.	115.0	108.7	93.0	95.5	95.0	97.5	98.5
Liquid Limit	36.4	42.6	56.0	52.7	47.3	46.8	57.5
Plasticity Index	4.8	22.9	25.9	22.9	13.3	19.7	31.5
Sieve Analysis							
Percent Passing Sieve Number							
3"	96.7	100	100	97.5	100	100	100
1.5"	78.8	91.6	96.4	94.6	99.2	95.2	98.7
3/4"	66.1	72.8	94.6	93.0	98.7	93.0	98.0
3/8"	59.2	62.3	92.5	89.7	98.7	88.9	97.6
#4	51.4	52.7	90.2	87.6	97.8	86.3	97.1
#10	43.8	41.3	87.0	84.4	96.4	83.2	95.7
#40	33.4	28.4	77.7	71.4	84.5	73.8	90.9
#60	29.2	25.8	73.6	67.5	78.9	69.7	88.0
#100	25.0	22.7	68.4	64.2	71.7	66.3	85.5
#200	21.9	19.8	62.9	60.6	65.3	62.8	81.7

SALT LAKE BOULEVARD WIDENING | PLATE NO 22

MAURSETH HOWE ASSOCIATES | FILE NO 117-026-01

OAHU STADIUM

TRUE NORTH
Scale: 1 in. = 40 ft.

INTERSTATE HIGHWAY

℄ Future Halawa Heights Road

proposed widening

T.P. 4

T.P. 3

END OF PROJECT

existing Salt Lake Boulevard

26 27 W-36" 28 ℄ 29 30 W-36" 31 32 W-36"

W-36"

G-4"

T.P. 2

top of bank

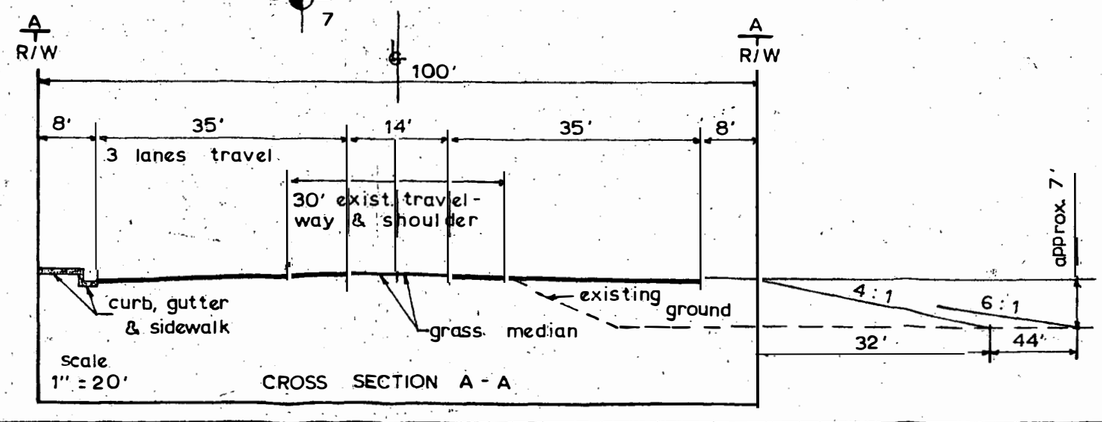
T.P. 1

G-4"

EXISTING SURCHARGE AREA

APPROX 72'

6 toe of bank 7 4 5 2



MAURSETH HOWE LOCKWOOD & ASSOC.

FOUNDATION ENGINEERS ENGINEERING GEOLOGISTS

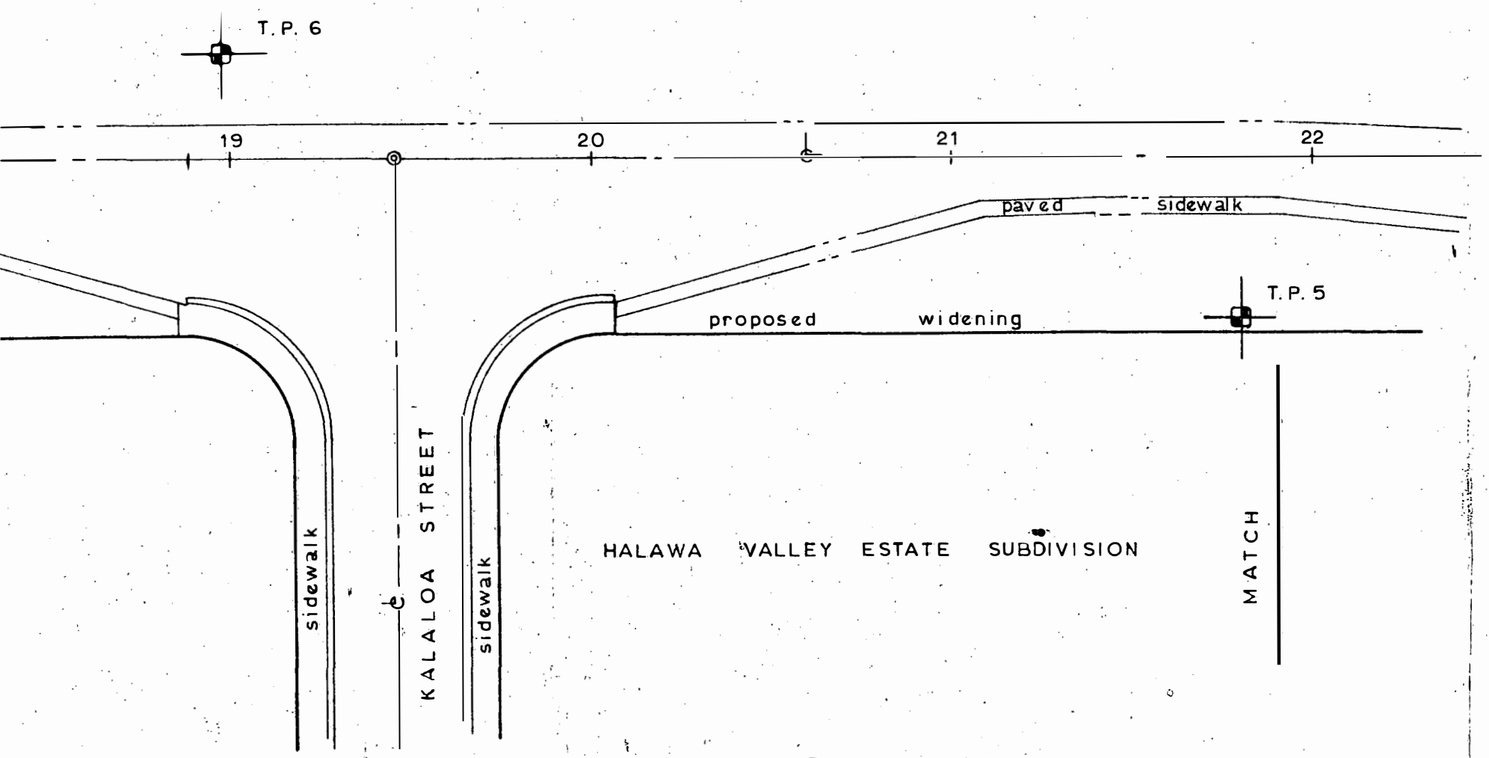
SALT LAKE BOULEVARD WIDENING
for
D. A. G. S.

FILE NO. 117-026-01	DATE 8-10-73	PLATE NO. 2

DAHU

STADIUM

LINE



PLAN

REFERENCE

WORKSHEET
by
D.A.G.S. - SURVEY DIVISION
DATED MAY 10, 1973

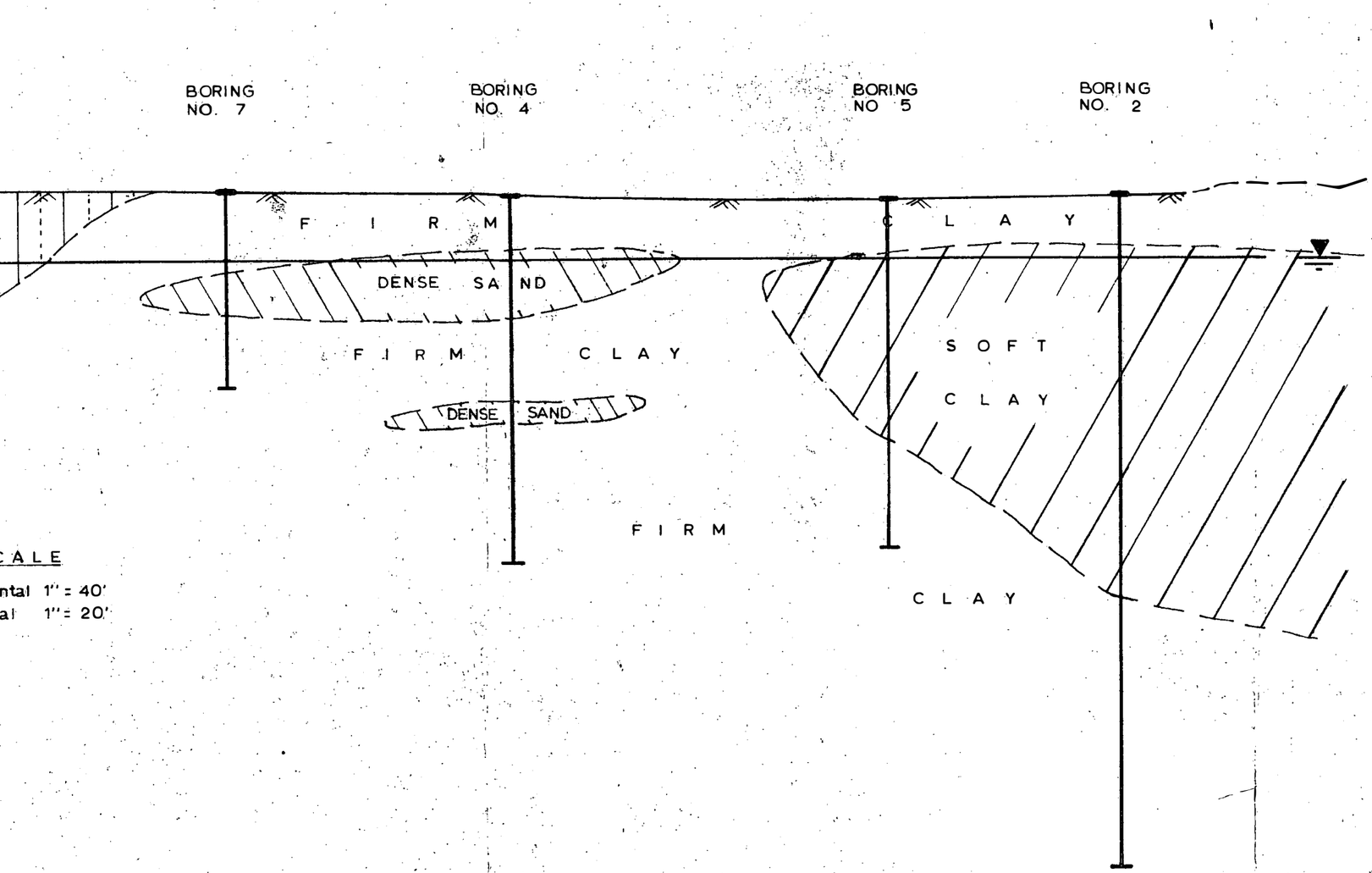
LEGEND

TEST PIT LOCATIONS

MAURSETH HOWE LOCKWOOD & ASSOC.
FOUNDATION ENGINEERS ENGINEERING GEOLOGISTS

SALT LAKE BOULEVARD WIDENING for STATE OF HAWAII, D.A.G.S.

FILE NO. 117-026-01	DATE. 8-21-73	PLATE NO. 3



LEGEND

- SOFT CLAYS
- FIRM CLAYS
- DENSE SANDS
- GRAVEL

CALE

ntal 1" = 40'
al 1" = 20'

PROFILE

MAURSETH HOWE LOCKWOOD & ASSOC.
FOUNDATION ENGINEERS ENGINEERING GEOLOGISTS

SALT LAKE BOULEVARD WIDENING for STATE OF HAWAII, D.A.G.S.

FILE NO. 117-026-01	DATE 8-15-73	PLATE NO. 4